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DEVELOPMENT OF VIRTUAL MODELLING FOR OPTIMIZATION AND BOTTTLENECK ANALYSIS OF AN AUTOMOTIVE STAMPING USING PLANT SIMULATION

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ABSTRACT

The main objective of the project is to perform bottleneck analysis, optimization for an automobile manufacturing layout using discrete event simulation method. An Automobile Manufacturing layout usually contains departments such as Stamping, BIW (Body in White), Painting, Assembly and Final Inspection. In this work, stamping department is selected to perform the bottleneck as well as optimization process. The simulation software Plant Simulation (Technomatix) is used to organize the lean manufacturing, flexible and efficient production process. The project validates the process performance, eliminating inefficiencies shortening lead times and increasing quality. Here, the project proposes an engineering of an ongoing re-enactment planning framework that consolidates the utilization of an instrument's tools with simulation and scheduling methods. The simulation study is focused on the validation of various options for increasing the total production quantity of the production system.

KEYWORDS: Discrete Event Simulation, Modelling, Technomatix, Bottleneck, Scheduling & Optimization

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Original Article

INTRODUCTION

Most of the Automobile industries follow a systematic procedure for the layout, which makes the raw material to flow in a convenient manner without any obstacles. The departmental path followed by most of the industries is as follows.

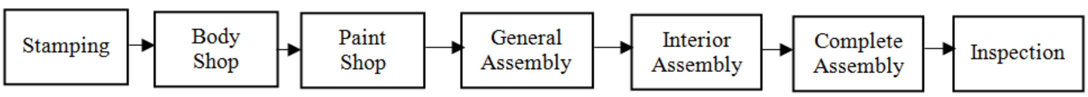

Figure 1: Automotive Plant Production Process

The flow of departments at any manufacturing industry is responsible for simulation concerns for both running production and for design of new manufacturing facilities. Fair models have been developed for each part of the department with in the plant, in order to provide better flow optimization and bottleneck. The Discrete event simulation (DES) is used as a tool for implementing new layouts with in the plant. Tecnomatix is a collection of programs for the optimization and design of technological lines, developed by Siemens. Tecnomatix platform is

composed of: Tecnomatix Jack, Intosite, Robcad and Plant Simulation. Plant Simulation is a tool for the simulation of discrete events, which allows creation of digital models of logistics, so that properties of technological lines can be examined and their performance can be optimized.

FLEXSIM

FlexSim is a program for creating discrete events simulations developed by FlexSim Software Products Inc. Family of FlexSim programs currently consists of basic simulation software FlexSim and FlexSim Healthcare Simulation (FlexSim HC). The main program uses the OpenGL environment to render 3D images in real time. It is possible to simulate not only the work of machines and conveyors but also working men, robots or forklifts. Product Life cycle Management (PLM) seeks to ensure that all interested parties have at the moment access to the right information about the product. Management of the product life cycle can be understood as a strategy of the company, which seeks to help companies innovate, promote, advance and download products from the market, while underpinning the most advanced methods and knowledge throughout the life cycle of the product.

PROBLEM STATEMENT

What is the Throughput (Final Number of Products)?

The measure of time required for an item to go through a producing process, in this manner changing over crude materials into completed products. It is the least demanding approach to decrease fabricating throughput time by taking out as much examination, move, what's more, line time as could be allowed. Throughputis net sales minus totally variable expensesthat give us the final value.

How Big Should the Buffers before the Bottlenecks be?

The larger the buffers, the less likely it is that a bottleneck will shift. Through decoupling, there will be increase in inventory and system response time that becomes more sluggish. Buffer is used to reduce bottleneck by decoupling your bottleneck, Update or install new machines, improve change overs, reduce scrap, improve maintenance.

LITERATURE REVIEW

Simulation allow us to use new strategies and procedures, verification of the production in the revised system, locate bottlenecks in the flow of materials, increase productivity while reducing inventory and reduce the cost of the implemented changes (Hromada & Plinta et al., 2000) [2].

According to Goldratt et al., (2004) [6], identifying a bottleneck in the system is the first stage of managing constraints according to the Theory of Constraints. Betterton, 2012; Hsiao et al., (2010) [1] stated, a bottleneck is determined as a workstation limiting the production efficiency of the entire process.

Stanley and Kim et al., (2012) [4] presented results of simulation experiments made for buffer allocation in closed serial-production line. For a line, a single buffer space is the room and the associated (material) handling equipment that is needed to store a single job that is a work-in-process, and buffer allocation is the specific placement of a limited number of buffers in a production line.

Boruvka, Manlig and Kloud et al., [7] determined minimum number of pallets necessary for ensuring the maximum utilization of production lines. Using specific examples, it is shown that elimination of 5% bottlenecks leads to

approx. 5% increase of production.

STAMPING AND DATA COLLECTION

This is the replica of the stamping process layout, which undergo several stamping stages with in the automobile manufacturing plant. Here, the process begins from sheet metal cutting and are placed on the dies with the help of pick and place robots, which carry the metal sheets and place it on metal dies to perform the stamping process. Once the parts are stamped, the unnecessary metal is separated or passed to the waste inventory. The parts that undergoes in the stamping process are Roof, Bumper, Front and Back Bonnet, Left and Right Doors, Inner and Outer Panels. After the parts are stamped, they are picked by the robots which work simultaneously on a single stamping machine (for example two robots work on a single machine), place the parts on a conveyor and these parts are picked and placed into the stands by the human effort.

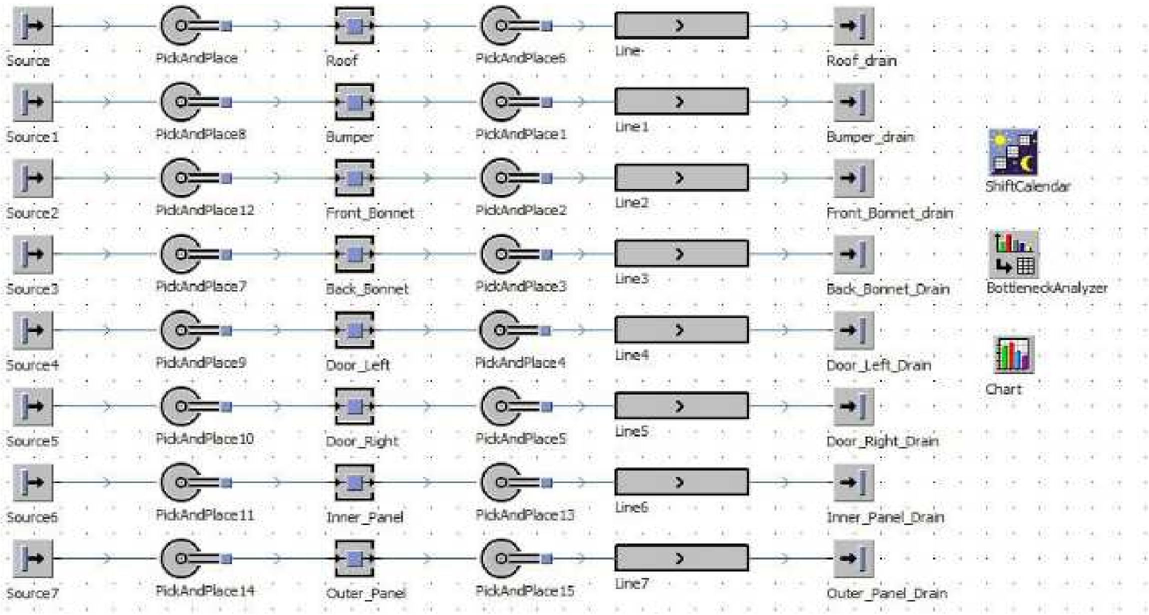

Figure 2: Layout of Stamping

Three shifts were given for the above layout in the simulation software

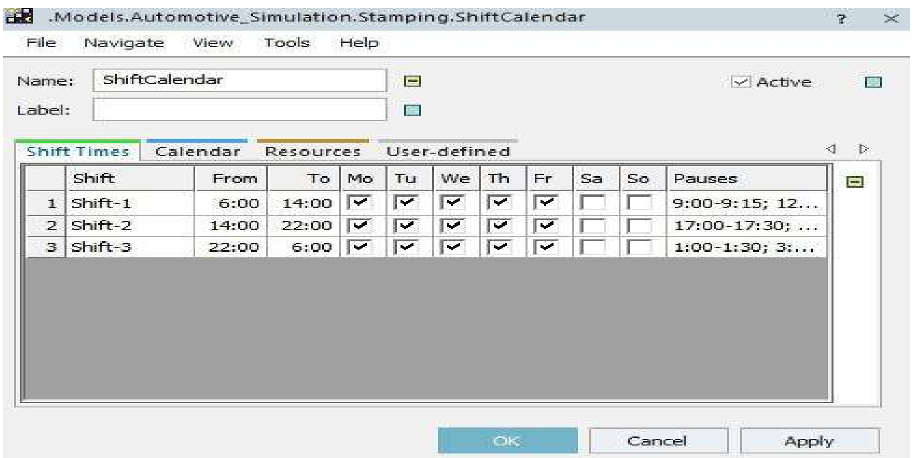

Figure 3: Shifts for Automobile Plant Process

Table 1: Process Parameters for Stamping

Name	Processing Time	Set Up Time
Pick and Place	8 Sec	-
Roof	40 sec	20 sec
Bumper	40 sec	20 sec
Front Bonnet	25 sec	15 sec
Back Bonnet	25 sec	15 sec
Door Left	15 sec	8 sec
Door Right	15 sec	8 sec
Inner Panel	20 sec	10 sec
Outer Panel	20 sec	10 sec

For all the processes, the failure time i.e. MTTR given is 2%

METHODOLOGY

Definition of Problem

Each examination should start with an announcement of the issue. In event that the announcement is given by the policymakers or those that have the issue, the examination must guarantee that the issue being portrayed is obviously comprehended. In the event that an issue articulation is being created by the examination, it is essential that the policymakers comprehend and concur with the plan. In spite of the fact that not appeared in Figure 4, there are events where the issue must be reformulated as the investigation advances. In numerous cases, policymakers and investigators are mindful that there is an issue, sometime before the idea of the issue is known.

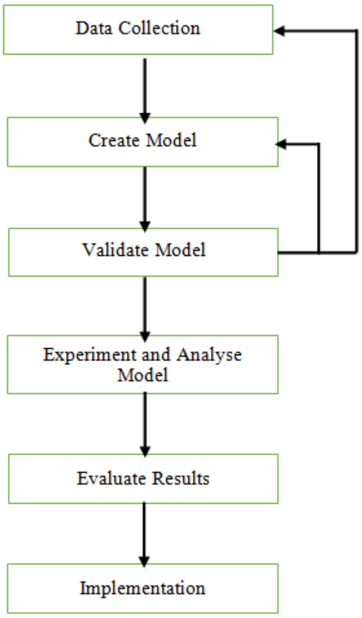

Figure 4: Method for Discrete Event Simulation

Data Collection

There is a relentless exchange between the advancement of the display and the amassing of the required data

[Shannon, 1975]. As the intricacy idea of the model changes, the required data segments can in like manner change. Also, since data aggregation takes such an extensive bit of the absolute time required to play out a recreation, it is important to start as ahead of schedule as could be allowed, normally together with the beginning times of model

structure. The goals of the investigation manage, in a huge way, the sort of information to be gathered. In the investigation of a bank, for instance, if the want is to find out about the length of holding up lines as the number of tellers changes, the kinds of information required would be the appropriations of interarrival times (at various occasions of the day), the administration time conveyances for the tellers, and noteworthy circulations on the lengths of holding up lines under changing conditions. This last sort of information will be utilized to approve the demonstrate by Henderson [2003].

Implementation

The accomplishment of the execution stage relies upon how well the past eleven stages have been performed. It is moreover dependent upon how altogether the examination has included the extreme model client amid the whole reenactment process. In the event that the model client has been included amid the whole demonstrate building process and if the model client comprehends the nature of the model and its yields, the probability of a dynamic usage is upgraded [Pritsker, 1995]. Alternately, if the model and its hidden suppositions have not been appropriately imparted, usage will most likely endure, paying little respect to the reenactment model's legitimacy. The reproduction display building process appeared in Figure 4 can be separated into four stages. The principal stage, comprising of stages 1 (Problem). The second stage is identified with model building and information gathering and incorporates stages 3 (Create Demonstrate), 4 (Validate Model), 5 (Experiment and Analyze Demonstrate), 6 (Evaluate Results). A proceeding with interchange is required among the means. Precluding of the model client amid this stage can have critical ramifications at the season of usage.

RESULTS

These results were obtained for 7 days of time.

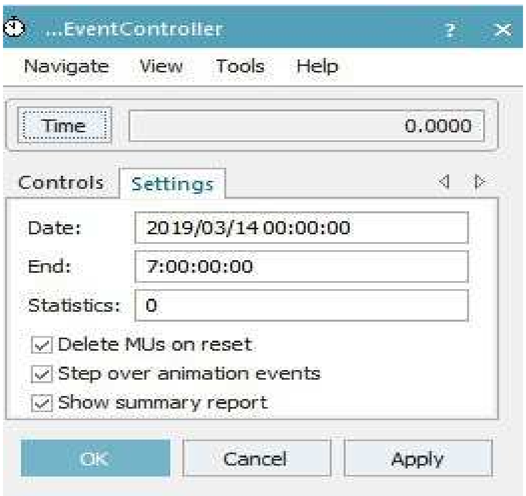

Figure 5: Schedule time for the Stamping process

Simulation time: 7:00:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Roof_Exit1	Entity	5:00.5537	5392	52	57.78%	42.22%	0.00%	13.31%	
Bumper_Exit1	Entity	5:27.3653	5433	52	62.00%	38.00%	0.00%	12.22%	
Front_Bonnet_Exit1	Entity	3:38.8689	8164	79	49.89%	50.11%	0.00%	11.42%	
Door_Left_Exit1	Entity	2:40.4603	11119	107	57.46%	42.54%	0.00%	9.35%	
Door_Right_Exit1	Entity	2:45.1315	10814	104	47.42%	52.58%	0.00%	9.08%	
Back_Bonnet_Exit1	Entity	3:41.8889	8099	78	59.96%	40.04%	0.00%	11.27%	
Inner_Panel_Exit1	Entity	3:08.0637	9469	91	49.22%	50.78%	0.00%	10.63%	
Outer_Panel_Exit1	Entity	2:51.2794	9440	91	54.51%	45.49%	0.00%	11.68%	

Figure 6: Throughput without Buffer for Stamping

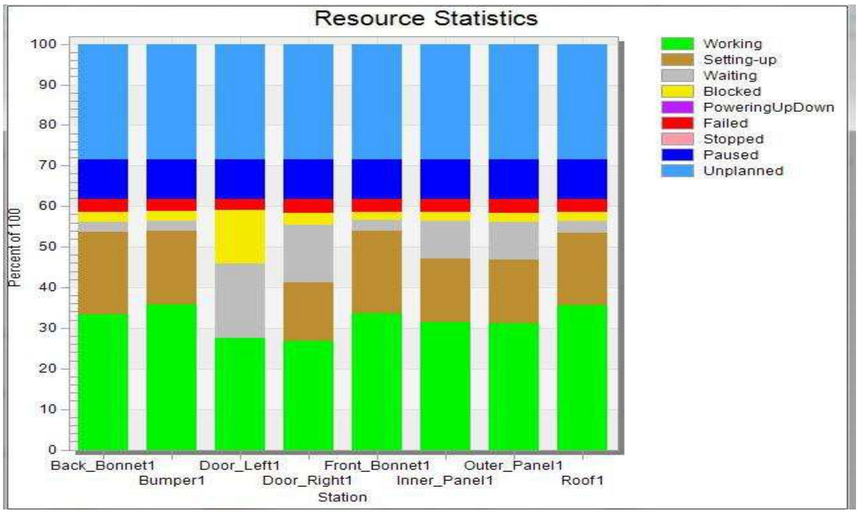

Figure 7: Bar Chart without Buffer for Stamping

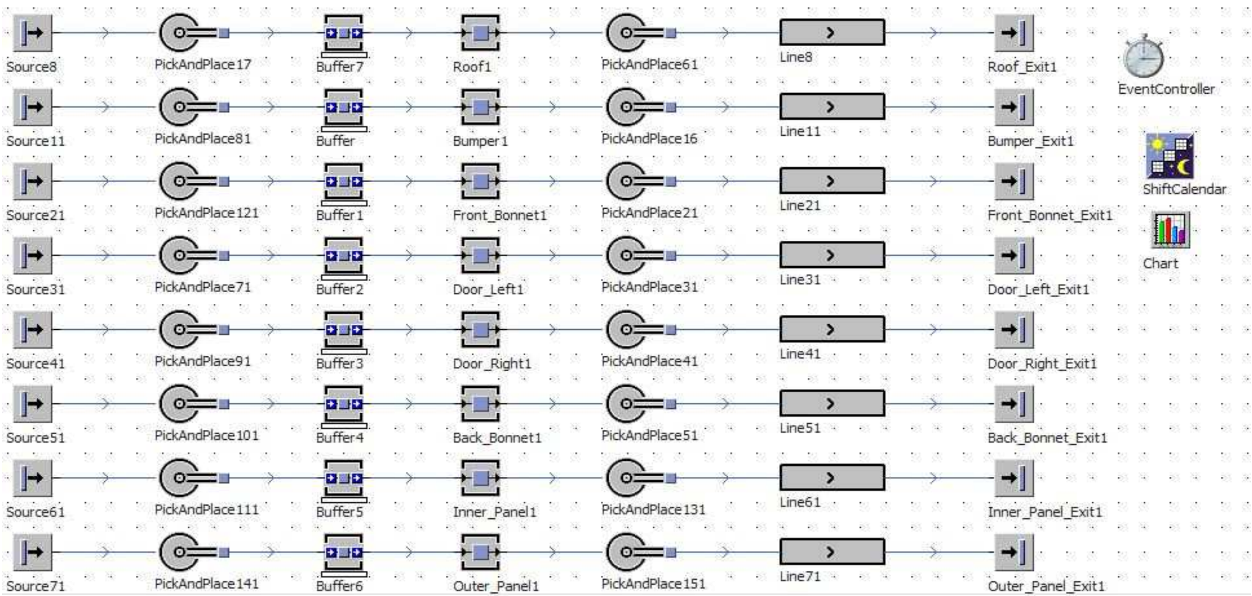

Figure 8: Buffers in the layout for Stamping

Simulation time: 7:00:00:00.0000

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
Roof_Exit1	Entity	16:15.0484	5649	54	14.65%	9.24%	76.11%	4.10%	
Bumper_Exit1	Entity	16:27.5922	5581	54	14.61%	9.22%	76.17%	4.05%	
Front_Bonnet_Exit1	Entity	10:46.1431	8461	82	14.06%	10.14%	75.81%	3.87%	
Door_Left_Exit1	Entity	6:38.2981	13242	128	13.69%	11.76%	74.55%	3.77%	
Door_Right_Exit1	Entity	6:38.2740	13009	125	13.85%	11.92%	74.22%	3.77%	
Back_Bonnet_Exit1	Entity	11:01.7209	8373	81	13.97%	10.00%	76.03%	3.78%	
Inner_Panel_Exit1	Entity	8:02.1826	11181	108	13.95%	10.66%	75.39%	4.15%	
Outer_Panel_Exit1	Entity	8:04.1806	11109	107	14.02%	11.01%	74.97%	4.13%	

Figure 9: Throughput with Buffer for Stamping

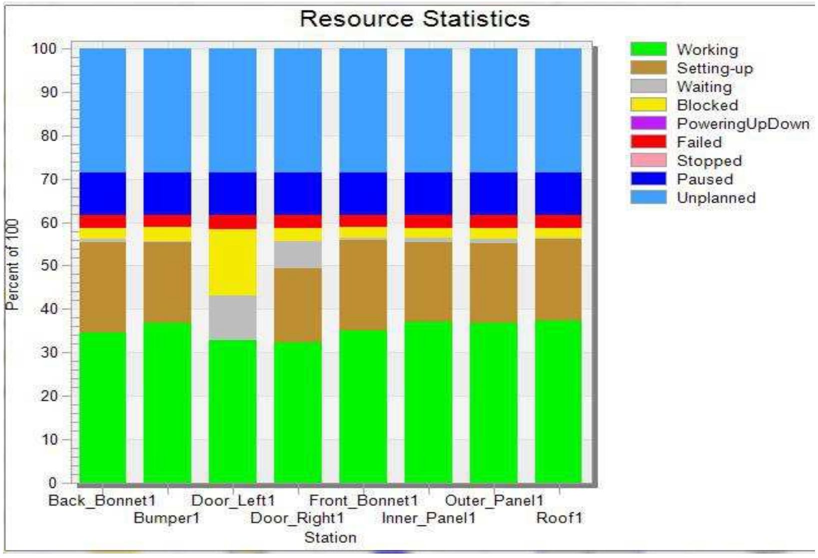

Figure 10: Chart with Buffer for Stamping

8. CONCLUSIONS

The issue of a bottleneck is one of the center issues looked by generation endeavors. The result of the paper is experimentally verified by using Plant simulation software. The performance of the stamping process is measured by calculating the throughput. DES can be applied successfully for improving the production line. The results show a reduced disparity between the stations. The productivity increased relative to capacity and the arrival time. The simulation model is improved in order to get a balanced output with in the best time, by avoiding as many problems as possible. The Bottlenecks in the system is reduced for a better workflow. It is reduced by placing buffers before the processes and the throughput has been increased. The future research on such works can be towards automating the manual systems with an objective of high productivity.

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